NASA Facts

National Aeronautics and
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Marshall Space Flight Center
Huntsville, Alabama 35812

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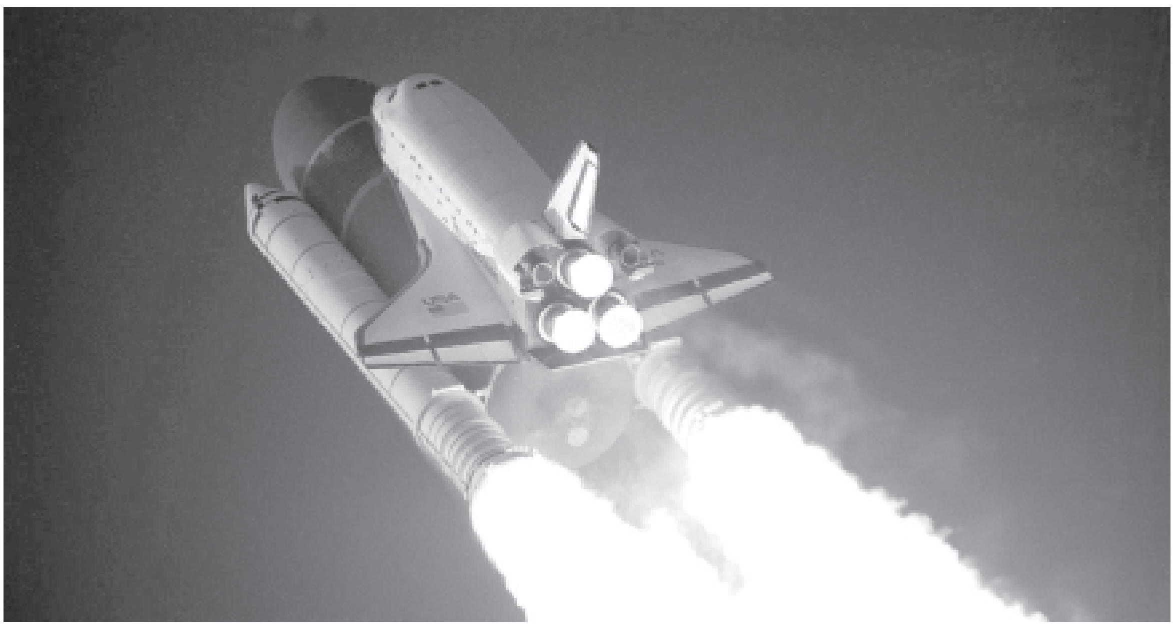
A Walk Around the Space Shuttle



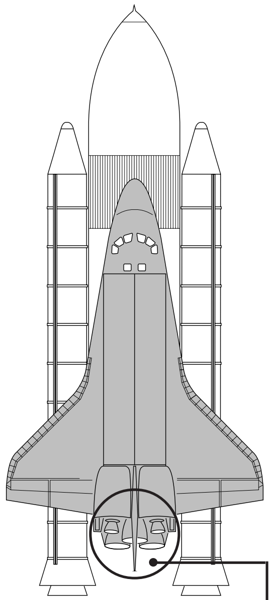
The Space Shuttle's superlative design provides capabilities and flexibility unmatched by any other launch system. The Shuttle's major components are:

- The orbiter spacecraft;
- The orbiter's three main engines, with their combined thrust of more than 1.1 million pounds (495,000 kilograms);
- The huge external fuel tank that feeds the liquid hydrogen fuel and liquid oxygen oxidizer to the orbiter's three main engines; and
- The two solid rocket boosters, which provide most of the power for the first two minutes of flight with their combined thrust of some 4.2 million pounds (1.9 million kilograms).

Together, these elements make up the Space Transportation System. Here's how they work to put the Shuttle in orbit:

The solid rocket boosters take the Space Shuttle with its external tank to an altitude of 28 miles (45 kilometers) at a speed in excess of 3,000 mph (4,800 kilometers per hour). At that point, they separate from the external tank and fall into the ocean to be retrieved, refurbished and prepared for another flight. After the boosters are jettisoned, the orbiter's three main engines, fed by the external fuel tank, continue to provide thrust for six more minutes before they are shut down. At that time, the giant tank is jettisoned and falls to Earth, disintegrating in the atmosphere.

The Space Shuttle Orbiter



The orbiter is both the brains and heart of the Space Transportation System. About the same size and weight as a DC-9 aircraft – 122 feet (37 meters) long and weighing 230,000 pounds (103,500 kilograms) — the orbiter contains the pressurized crew compartment (which normally carries up to seven crew members), the huge cargo bay and the three main engines mounted on its aft end.

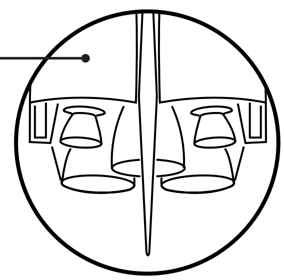
There are three levels to the crew cabin. Uppermost is the flight deck where the commander and the pilot control the mission, surrounded by an array of switches and controls. During the launch of a seven-member crew, two crew members are positioned on the flight deck behind the commander and pilot. The three other crew members are seated in the mid-deck, below the flight deck.

The mid-deck is where the galley, toilet, sleep stations, and storage and experiment lockers are found for the basic needs of daily living in microgravity. Also in the mid-deck are the orbiter's side and airlock hatches. The crew uses the side hatch to enter and exit the orbiter before and after a mission, and the airlock hatch during orbit to access the cargo bay and space beyond. Crew members go through this hatch and airlock to put on their spacesuits and manned maneuvering units to prepare for extravehicular activities, or "spacewalks." These spacewalks have produced some of the most important space firsts in the Shuttle program, as well as the most spectacular photographic vistas of the Space Age. Below the mid-deck floor is a utility area, for air and water tanks and their ducts.

The Space Shuttle's cargo bay is adaptable to hundreds of tasks. Large enough to accommodate a tour bus (60 by 15 feet, or 18.2 by 4.6 meters), the cargo bay carries satellites, spacecraft and scientific laboratories to and from Earth orbit. It also is a work station for the crew to repair satellites, a foundation from which to erect space structures, and a hold for retrieved satellites to be returned to Earth.

Mounted on the port side of the cargo bay behind the crew quarters is the remote manipulator system — a robot arm and hand with three joints similar to those of the human shoulder, elbow and wrist. It is operated from the orbiter's flight deck. Some 50 feet long, the arm can move satellites and crew to and from the cargo bay, or to different points in nearby space.

Thermal tile insulation and blankets, also known as the thermal protection system, cover the underbelly, bottom of the wings and other heat-bearing surfaces of the orbiter, protecting it during its fiery reentry into the Earth's atmosphere. The thermal tiles were a breakthrough technology that proved much more challenging to design than expected. Designed for use on 100 missions before replacement is necessary, the Shuttle's 24,000 individual tiles are made primarily of pure sand silicate fibers mixed with a ceramic binder. Incredibly lightweight — about the density of balsa wood — they dissipate heat so quickly that a white-hot tile with a temperature of 2,300 degrees Fahrenheit (1,260 degrees Celsius) can be taken from an oven and held in bare hands without injury.



The Main Engines and Orbital Propulsion Systems

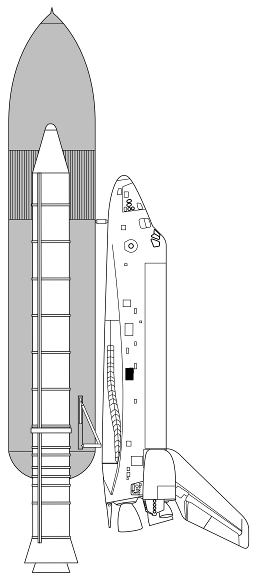
The Shuttle's three main engines — the world's first reusable rocket engines — are clustered at the aft end of the orbiter and have a combined thrust of more than 1.1 million pounds (495,000 kilograms) at sea level. Fourteen feet (420 centimeters) long and 7.5 feet (225 centimeters) in diameter at the nozzle exit, they are high-performance, liquid-propellant rocket engines whose thrust can be varied from 65 to 109 percent of their rated power level. Today's engines operate for about 10 flights before needing major overhaul.

Each engine runs for about eight-and-a-half minutes during the Shuttle's ascent. Once in orbit, the Shuttle uses two orbital maneuvering system engines, mounted on either side of the upper aft fuselage, to thrust for major orbital changes. For more exacting motions in orbit, 44 small rocket engines, clustered on the Shuttle's nose and on either side of the tail, are used. Together they are known as the reaction control system and aid in retrieving and launching satellites in orbit.

The Marshall Center is introducing redesigned high-pressure oxidizer and hydrogen turbopumps into the main engine fleet. The turbopumps deliver liquid hydrogen and liquid oxygen to the Shuttle engine's main

combustion chamber for ignition. The new pumps have more than 900 fewer welds than the previous design. The reduction in welds improves engine reliability and safety, and reduces the time spent on inspecting the engines. The first redesigned oxidizer pump flew in July 1995. The first hydrogen turbopump is scheduled to fly in 2001.

The External Tank



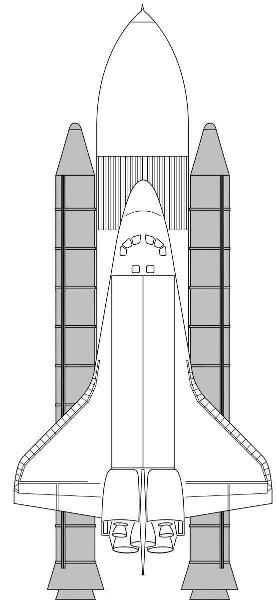
The External Tank, a giant cylinder taller than a 15-story building with a length of 154 feet (46.7 meters) and a diameter of 27.5 feet (8.4 meters), is the largest single piece of the Space Shuttle. During launch, the external fuel tank also acts as a backbone for the orbiter and solid rocket boosters, which are attached to it.

Inside the tank, separate pressurized sections hold the liquid hydrogen fuel and liquid oxygen oxidizer for the Shuttle's three main engines. During launch, the external tank feeds the fuel through 17-inch ducts that branch off into smaller lines feeding directly into the main engines. The engines consume some 66,000 gallons (250,800 liters) of fuel each minute.

A new version of the external fuel tank — the super lightweight tank — is about 7,500 pounds (3,375 kilograms) lighter than the previous design. The reduced weight is the result of component redesign and the use of an aluminum-lithium alloy. The first super lightweight tank flew on the STS-91 mission in June 1998.

The Shuttle's external tank is the only part of the launch vehicle not reused. After its 535,000 gallons (2.03 million liters) of propellants are consumed during the first eight-and-a-half minutes of flight, it is jettisoned from the orbiter.

The Solid Rocket Boosters



The Shuttle's two solid rocket boosters — the first boosters designed for reuse – are the largest solid boosters ever built and the first to be flown on a crewed spacecraft. They provide 80 percent of the thrust — some 5.2 million pounds (2.3 million kilograms) — for the first two minutes of flight. The boosters provide the equivalent of a 40-million-horsepower motor and burn an average of 9 tons of solid propellant per second.

The solid propellant mix is 16 percent aluminum powder for fuel, and almost 70 percent ammonium perchlorate, or oxidizer. The remainder is a binder, a curing agent and small amount of catalyst.

The twin boosters are made up of three major parts: a forward assembly, a solid rocket motor and an aft skirt. They serve as the Shuttle's structural support for stacking, rollout and launch. A small rocket motor in each booster ignites the propellant at liftoff. When ignited, the motors reach full power in about one-half second. During flight, the solid booster nozzles can swivel up to 6 degrees, redirecting the thrust and steering the Shuttle toward orbit.

About two minutes into flight the spent boosters separate from the vehicle. They coast upward for more than a minute before parachuting into the Atlantic Ocean. Ships recover the boosters and tow them back to the Kennedy Center, where they begin the process of refurbishment for the next flight.

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